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ZOOLOGY.

Vol. I, No. 9.

The Gordiacea of Certain American
Collections, with Particular Reference
to the North American Fauna.

II.

BY

THOMAS H. MONTGOMERY, JR., PH. D.,

Lecturer in Zoology, University of Pennsylvania.

WITH TWO PLATES.

Issued October 12, 1898.

SAN FRANCISCO:
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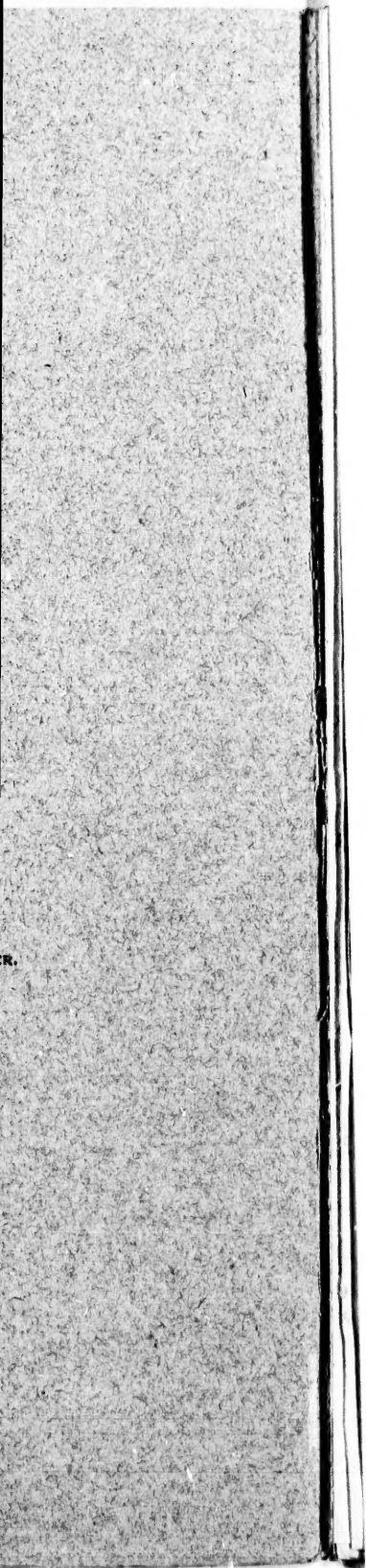
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THE GORDIACEA OF CERTAIN AMERICAN
COLLECTIONS, WITH PARTICULAR REF-
ERENCE TO THE NORTH AMERICAN
FAUNA.—II.

BY THOMAS H. MONTGOMERY, JR., PH. D.,

Lecturer in Zoology, University of Pennsylvania.

PLATES XIX AND XX.

THE present paper deals with Gordiacea, principally of California, and with a few specimens from neighboring regions (Baja California, Arizona, Nevada, and Mexico). The fauna of California has been heretofore but little known, so that the comparatively large number of specimens from that locality which have been offered to me for study have a special interest. In a previous contribution¹ Gordiacea were described by me from other portions of North America.

The following collections are herein described: that of the California Academy of Sciences, San Francisco; of the University of California; and of Stanford University, California. For the opportunity to study these collections, my thanks are due to Dr. Gustav Eisen of the California Academy of Sciences, and to Prof. Henry B. Ward of the University of Nebraska.

Appended to this paper is a Key for the determination of the species of Gordiacea on the North American continent, north of Mexico. While this key may serve to determine with rapidity certain species, it must be noted that some of them, and particularly the females of *Gordius* and *Chordodes*, can only be satisfactorily determined by means of sections and of portions of the cuticle cleared in glycerine or some clearing oil (I am accustomed to clear them in cedar oil, after dehydration, and to study them mounted in Canada balsam). For descriptions of species which are

¹ Bull. Mus. Compar. Zool., Harvard University, April, 1898.

here mentioned only briefly, the reader is referred to my previous paper, l. c. In this Key the females of *Gordius aquaticus difficilis*, *G. longareolatus*, n. sp., *Chordodes puerilis*, and the male of *C. morgani* find a place, though I have seen only the males of the first three mentioned, and the female of the last; this was done with the assumption that the cuticular characters of the two sexes are similar in these forms.

It is here shown that *Chordodes gordioides* Montg. is identical with *C. occidentalis* Montg.

1. *Gordius longareolatus*, sp. nov.

Type.—Coll. Cal. Acad. Sci.: 1 ♂, San Francisco, Cal., Sept. 10, 1896.

Form.—Of equal diameter in its whole length, nearly cylindrical, with faint median grooves. Head end (fig. 1) conically rounded, the tip slightly constricted off, mouth ventral (on the ventral side of the white tip of the head). Tail lobes (figs. 1, 3) short, thick, nearly parallel, terminally rounded. Their point of bifurcation (on the ventral surface) is at a distance from the oval cloacal aperture about equal to the length of the lobes. Each lobe is approximately cylindrical, except on its median surface which is concave; this concavity is deepest nearest the posterior end of the lobes and is bounded by a sharp line. The cloacal aperture is situated upon a slightly elevated papilla; from this papilla to the point of bifurcation of the tail lobes extends a deep groove (deepest caudad). The area around the cloacal aperture, and extending caudad to about the point of bifurcation of the tail lobes, is covered with numerous, minute, conical spines.

Cuticle.—With elevated areoles of elongate form, their longitudinal axes parallel to that of the body (fig. 4). The areoles do not produce particular longitudinal rows, though everywhere the spaces which separate them are about equal in length. They are darker than the intermediate portions of the cuticle. Most of them are several times longer than broad, with nearly parallel margins; a smaller number are shorter and thicker, but even these are somewhat elongate. On cross section of the body (fig. 5) the areoles are seen to be hyaline and homogeneous, their darker, denser bases sunk into the surface of the fibrous cuticle. On section they show a rounded-conical form, without any median groove. No hairs lie between the areoles, but widely separated from one another are found a few hyaline, finger-shaped processes, of slightly greater elevation than the areoles; such processes have heretofore been noticed by me only in the genus *Chordodes*.

Color.—Deep olive brown, slightly iridescent; the tip of the head white.

Dimensions.—Length, 115 mm.; greatest diameter, 0.5 mm.

Comparison.—The only other Gordiacea with longitudinally arranged elongate areoles are *G. raphaelis*, *alfredi*, and *latastei* of Camerano, and *G. abbreviatus* Villot; but all of these differ from *G. longiareolatus* in having the areoles longitudinally grooved.

2. *Gordius aquaticus* Linn.

Coll. Cal. Acad. Sci.: 2 ♂♂, City of Mexico; 2 ♂♂, Berkeley, Cal., winter of 1891. Coll. Univ. of Cal.: ♂, Berkeley, Cal., January, 1895.

These are the only specimens as yet seen by me of the true *aquaticus* from North America; in all of them the white spots (figs. 13, 14) are clearly marked on the surface of the cuticle and may be seen with a low-power hand lens.

3. *Gordius aquaticus robustus* (Leidy.)

Coll. Cal. Acad. Sci.: ♀, San Francisco, Cal.; ♀, Berkeley, Cal. Coll. Univ. Cal.: ♀, Berkeley, Cal., January, 1895.

The largest specimen measured 590 mm.

This is the form, corresponding to *G. robustus* Leidy, which has been regarded by me (l. c.) as a mere variety of the preceding, from which it differs merely in the absence of the white cuticular spots. In the true European *aquaticus* the white spots are present in most individuals, according to the description of Römer¹; while in specimens of *robustus* from the eastern United States (from Kansas eastward) I have never found these spots, though I have studied one or two hundred specimens. Westward of California occurs the true *aquaticus*, eastward the *aquaticus robustus*, while in California the two appear to overlap. If white-spotted specimens be subsequently found in any number from the eastern United States, then *aquaticus robustus* can no longer be retained as a separate subspecies; but with the facts at hand we are justified in assigning it that position.

¹ Beitrag zur Systematik der Gordiiden Abh. Seckenberg. Ges., Bd. XXXIII, 1896.

4. *Gordius densareolatus* Montg.

Coll. Cal. Acad. Sci.: ♂, Lake, San Francisco, Cal.

The posterior end of this specimen was as in the type (cf. Montgomery, l. c.), except that there was only a slight precloacal groove.

In my first description of this species (l. c.) the cuticle of the female only was described. I have since re-examined the type of the male (Montana, Leidy coll., No. 5063) and find the cuticle in general like that of the female, except that the areoles show less tendency to confluence and are more rounded in outline.

5. *Paragordius varius* (Leidy.)

Coll. Cal. Acad. Sci.: 2 ♂♂, 3 ♀♀, San José del Cabo, Baja Cal., July, 1896; ♀, St. Helena, Napa Co., Cal. Coll. Stanford Univ., collected by C. H. Gilbert: 5 ♀♀, Napa Creek, Calistoga, Napa Co., Cal., May 31, 1897.

This appears to have the broadest range of any North American species, extending completely across the continent, and, according to Camerano, into South America.

In the females the tail lobes may be either parallel or divergent, so that they are probably opened and closed by muscular action; while in the males of this genus and of *Gordius* these lobes appear to be to great extent independent of such action.

6. *Chordodes occidentalis* Montg.

Coll. Univ. Cal.: ♂, ♀, Berkeley, Cal. Coll. Stanford Univ., collected by C. H. Gilbert: 112 ♂♂, 42 ♀♀, Napa Creek, Calistoga, Napa Co., Cal., May 31, 1897. Coll. Cal. Acad. Sci.: 2 ♀♀, 1 ♂, Haywards, Alameda Co., Cal.; 1 ♀, Alameda Co., Cal.; 2 ♂♂, 2 ♀♀, Santa Rosa Isl., Cal.; 4 ♀♀, Sierra el Taste, Baja Cal.; 1 ♀, St. Helena, Napa Co., Cal.; 1 ♀, Kings River, Fresno Co., Cal.; 1 ♂, Lime Point, Marin Co., Cal.; 1 ♂, San Miguel de Comondu, Baja Cal.; 1 ♀, 5 ♂♂, locality not marked, but probably from California; 1 ♀, Battle Mountain, Nevada.

A careful examination of this large number of specimens shows that the *Chordodes gordioides* Montg. of my preceding paper was based upon immature specimens of *C. occidentalis* Montg., so that *gordioides* is not a tenable species.

Owing to the great amount of individual variation afforded by these specimens from California (123 ♂♂, 55 ♀♀,) a description of them is necessary, and this description may be compared with that of *occidentalis* and "*gordioides*" given in my preceding contribution.

Form.—The form of the male has already been described and figured, so that it is only necessary to note that the anterior portion of the body is the most slender, the head (fig. 10) pointed, and the body either cylindrical or flattened (depending upon the state of development of the genital products). The females resemble the males in general form, and in them also the anterior portion (fig. 6) is the most slender, they are stouter than the males; the posterior end (figs. 9, 13) is enlarged and more or less knob-shaped as in all females of this genus; seen from the ventral surface (fig. 23) this posterior end appears disc-shaped, with the cloacal aperture in its centre.

Cuticle.—Thirty-two specimens were examined, cleared in cedar oil, and transverse sections were made of twenty-four of them. These preparations, with those which formed the basis of my previous descriptions, show how variable the configuration of the cuticle is in this form, and present all intermediate phases between the figs. 115-117, Pl. XV, of *C. occidentalis* of my previous description, and figs. 106, 107, Pl. XIII, l. c., of *C. "gordioides,"* and leave no doubt that the latter is only the young of the preceding.

On surface view the areoles may be irregularly polygonal and well separated from one another, or they may be elongate and confluent so as to produce transverse rows (figs. 7, 12-20). The areoles of the same individual may be all of the same color, which appears to be usually the case, or groups (of a few each) of larger areoles may be darker than the others (fig. 18). The cuticle of one specimen had the appearance of that of *Gordius pleskei* Camer., owing to the incrustation of minute dirt particles between the areoles (fig. 12). Small, refractive, circular or oval pits occur in varying number on the cuticle; they lie for the main part between areoles, sometimes on their surfaces; their most frequent mode of occurrence is between two areoles which together present a dumb-bell shape; their number varies greatly, and they are found either singly, in pairs, or in threes (figs. 7, 15-20).

On transverse section (figs. 8, 11, 21, 22) the areoles are usually of the same height but varying diameter in the same individual, but are never as high as long, though in the males they are usually higher than in the females; they are either close together or well separated. In a few specimens, as in the type first figured, lower areoles with irregularly serrated summits lie between the higher ones, but such a relation was found in only three or four cases. Between the areoles, occurring only at wide distances, are delicate finger-shaped or club-shaped hyaline processes, of greater height than the areoles. In a few specimens were noticed hyaline processes of a stout conical form, sunk into the summits of certain of the areoles (fig. 22). In some males a cup-shaped depression occurs on the summits of a few of the areoles.

The circular or oval pits seen on surface views are found on section (fig. 8) to represent structures, the like of which has not yet been described for any Gordiacean; they were overlooked in my description of the type specimen,

owing to their paucity in that individual, but I have found them on re-examination. They were largest and most abundant in a large female, and appeared to be absent in only three specimens. Each pit has the form of a sack of spherical or ovoid shape (some are flattened parallel to the surface of the cuticle), with an exterior opening on the surface of the cuticle; the length of these sacks varies from about one-fourth to two-fifths the diameter of the cuticle. On section it would appear that almost all of them lie between areoles, sunk into the fibrous cuticle, though on surface view they frequently seem to lie on the summits of areoles. The outline of each pit is rounded and sharply demarcated, though no special limiting membrane appears to be present. In each lie two (rarely three) refractive spines, which are usually situated vertical to the surface of the cuticle, but in some cases parallel to it. Each spine is somewhat rod-shaped, thickest basally, the base obtusely rounded and usually in close contact with the wall of the pit. At its distal end each spine has a short, pointed process which projects out of the narrow opening of the pit; the longitudinal axis of this pointed portion does not always coincide with that of the basal portion. Thus these spines are somewhat similar in form to the central stilets (with their bases) of the *Metanemertean* proboscis.

Color.—The males vary from a light yellowish, through rufous or chocolate or olive-brown, to a nearly pitch black color, smaller individuals being usually but not always lighter than larger ones. In most of them the anterior portion of the body is lighter than the posterior; the head is lightest in color, very frequently yellowish white, while the rest of the body is chocolate-brown. Just behind the light head portion is usually a more or less pronounced dark neck ring, which is seldom wholly absent. The females average much lighter in color than the males, and are usually a yellowish or yellowish brown color; a few are a dark olive-brown, but none are black. In them, too, there is usually a darker neck ring, and often a brownish area around the cloacal aperture. In both sexes the mouth aperture is usually marked by a small black spot, easily seen with a hand lens: thus of the 154 individuals collected on the same day at the same locality (coll. Stanford University), 96 males showed this spot, 15 males were without it, and in 2 males the whole head was black; and all the 42 females showed the spot. The black mouth spot would thus appear to be pretty constant (though it was absent in the type specimens of this species).

Dimensions.—Largest male, 460 mm.; largest female, 430 mm.

Comparison.—*C. gordioides* Montg. becomes a synonym of this species. This species differs from *C. bedriagæ* and *C. pardalis* Camer., to which the configuration of its cuticle appears to be otherwise quite similar, in the presence of the remarkable cuticular pits, the structure of which, however, can only be determined by sections. Such pits have never heretofore been described: but clear, rounded cavities situated just below tubercles or areoles of the cuticle

would seem to be frequent in *Chordodes*, at least I find them in my species of *C. morgani*, *C. puerilis*, and *C. albi-barbatus*, though not in *C. furnessi*.

General diagnostic characters.—The union of the following characters serves to distinguish this from any other North American form: the low aeroles with the remarkable interareolar pits, the attenuation of the anterior portion of the body, and the black mouth spot. The females of this species may easily be mistaken for females of *G. densareolatus* Montg., since in some specimens of the former the interareolar pits may be very few in number (or entirely wanting?). But the form of the posterior end is a good distinguishing character: in the female of *C. occidentalis* it is enlarged—somewhat knob-shaped, while in the female of *G. densareolatus* it is not of greater size than the preceding portion of the body; there is at least no difficulty in distinguishing them when one has a series of specimens of both before him.

KEY TO THE SPECIES OF GORDIACEA OF THE NORTH AMERICAN CONTINENT, NORTH OF MEXICO.

- I. Posterior end trilobed *Paragordius varius* (LEIDY), ♀.
- II. Posterior end bilobed, spirally inrolled. (*Paragordius* and *Gordius*, ♂♂).
 - A. A sharp, V-shaped cuticular ridge behind the cloacal aperture.
 - a. The cuticle dotted with white spots. *Gordius aquaticus* LINN., ♂.
 - b. The cuticle not dotted with white spots.
 1. A parabolic line of hairs on the tail lobes. *G. a. difficilis* MONTG., ♂.
 2. No line of hairs on the tail lobes. *G. a. robustus* (LEIDY), ♂.
 - B. No sharp, V-shaped cuticular ridge behind the cloacal aperture.
 - a. A longitudinal line of long hairs on each side of the cloacal aperture. *G. lineatus* LEIDY, ♂.
 - b. No line of long hairs on each side of the cloacal aperture.
 1. Head end obliquely truncated. *Paragordius varius* (LEIDY), ♂.
 2. Head end not obliquely truncated.
 - a. Conical spicules behind the cloacal aperture.
 1. Tail lobes short, nearly conical. *Gordius densareolatus* MONTG., ♂.
 2. Tail lobes nearly cylindrical. *G. longareolatus* MONTG., ♂.

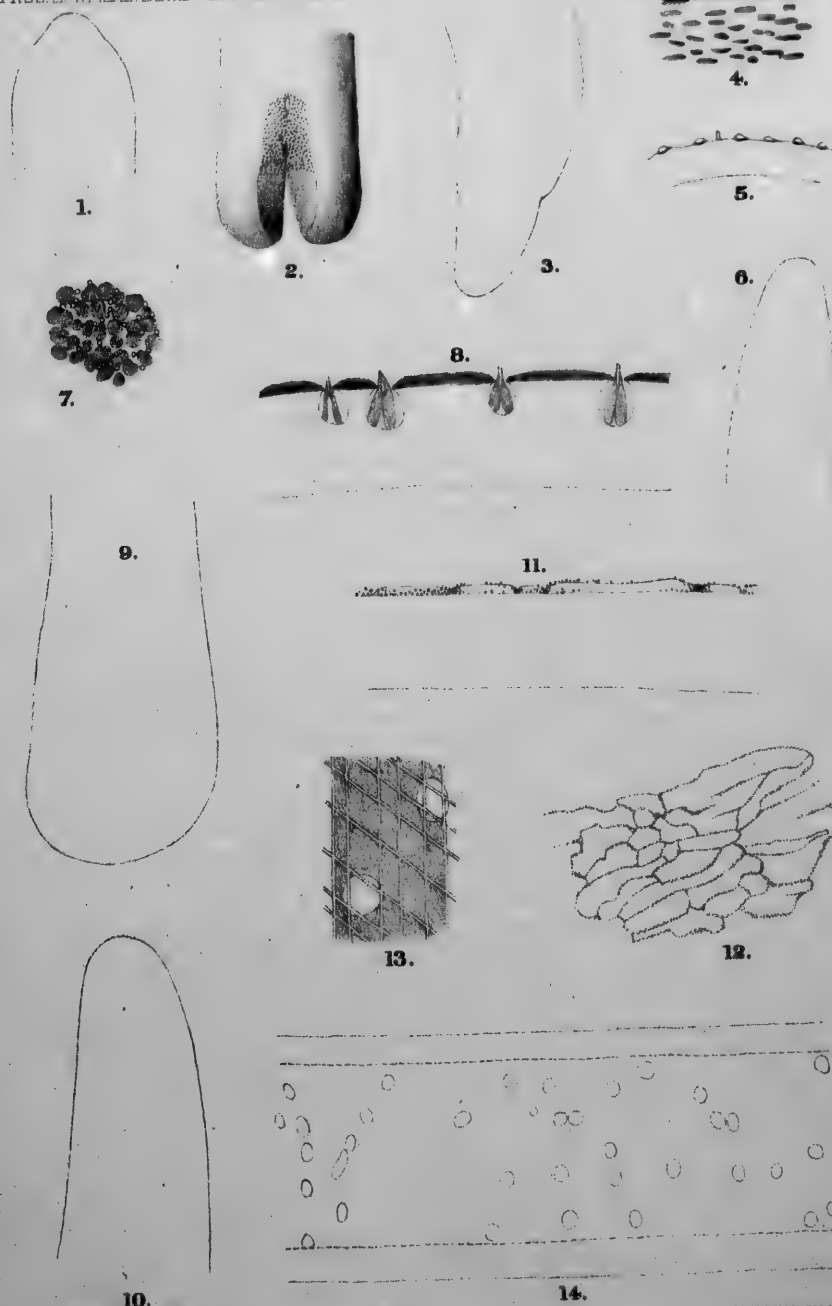
- δ. No conical spicules behind the cloacal aperture.
G. platycephalus MONTG., δ.
- III. Posterior end not lobed, spirally inrolled, with a depression or groove on its ventral surface, narrower than preceding portion of body.....(*Chordodes*, δ δ).
- A. Cuticular areoles longer than high, on and between them small circular pits.....*Chordodes occidentalis* MONTG., δ.
- B. Cuticular areoles higher than long.
- a. Spines on the summits of the highest papillæ.
C. puerilis MONTG., δ.
- b. No spines on the summits of the highest papillæ.
C. morgani MONTG., δ.
- IV. Posterior end not lobed, not spirally inrolled.
- A. Posterior end not noticeably enlarged.....(*Gordius*, ♀ ♀).
- a. With elevated cuticular areoles on the whole surface of the body.
1. With paired dark stripes in the median lines.
Gordius leidyi MONTG., ♀.
2. No dark stripes in the median lines.
- a. Areoles elongated in the long axis of the body, well separated.....*G. longareolatus* MONTG., ♀.
- b. Areoles not elongated in the long axis of the body.
1. Areoles closely apposed, tending to produce longitudinal ridges.....*G. lineatus* LEIDY, ♀.
2. Areoles more or less confluent, tending to produce transverse rows, head usually cylindrical.....*G. densareolatus* MONTG., ♀.
3. Areoles usually separated, interareolar groups of fine hairs, head usually flattened.
G. platycephalus MONTG., ♀.
- b. Without elevated cuticular areoles on the whole surface of the body.
1. No cuticular areoles.
- a. Cuticle dotted with white spots...*G. aquaticus* LINN., ♀.
- b. Cuticle without white spots...*G. a. robustus* (LEIDY), ♀.
2. Cuticular areoles at the ends of the body only.
G. a. difficilis MONTG., ♀.
- B. Posterior end swollen, somewhat knob-shaped, slightly constricted off.....(*Chordodes*, ♀ ♀).
- a. Cuticular areoles longer than high, on and between them small circular pits.....*Chordodes occidentalis*, MONTG., ♀.
- b. Cuticular areoles higher than long.
1. Spines on the summits of the highest areoles.
C. puerilis MONTG., ♀.
2. No spines on the summits of the highest areoles.
C. morgani MONTG., ♀.



EXPLANATION OF PLATE XIX.

(All the outlines were drawn with the aid of the camera lucida and a Zeiss microscope and lenses. The cuticle is represented as seen in Canada balsam, after clearance in cedar oil.)

- Fig. 1. *Gordius longareolatus*, sp. nov., type. Head end (obj. A, oc. 2).
Fig. 2. Idem. Ventral view of posterior end (idem).
Fig. 3. Idem. Lateral view of the posterior end, the ventral side to the left (idem).
Fig. 4. Idem. Surface view of the cuticle, the arrow denoting the line of the longitudinal axis of the body (obj. C, oc. 4).
Fig. 5. Idem. Transverse section of the cuticle (homog. immers. 1/12, oc. 2).
Fig. 6. *Chordodes occidentalis* MONTG., dorsal view of the head of a female (obj. A, oc. 2).
Fig. 7. Idem. Surface view of the cuticle (obj. C, oc. 4).
Fig. 8. Idem. Transverse section of the cuticle (homog. immers. 1/12, oc. 4, tube length 180 mm.).
Fig. 9. Idem. Lateral view of the posterior end, the ventral side to the right (obj. A, oc. 2).
Fig. 10. *Chordodes occidentalis* MONTG., male. Lateral view of the head end (obj. A, oc. 2).
Fig. 11. Idem. Transverse section of the cuticle; in this figure, as in the following, dirt granules are imbedded between the areoles (homog. immers. 1/12, oc. 2).
Fig. 12. Idem. Surface view of the cuticle (obj. C, oc. 2).
Fig. 13. *Gordius aquaticus* LINN., male from Berkeley, California. Surface view of the cuticle; the intersecting clear lines transverse the white spots (obj. C, oc. 2).
Fig. 14. Idem. Surface view of the body, as seen with low magnification (obj. A, oc. 2), to show the arrangement of the white spots. The continuous lines represent the outlines of the body, the dotted lines the area to which the drawing was limited.



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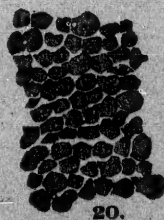
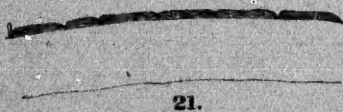
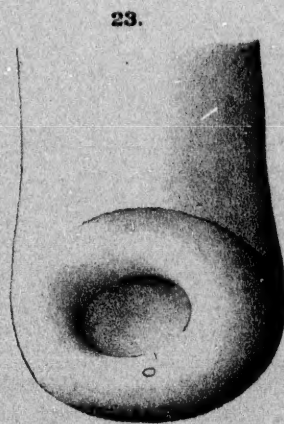
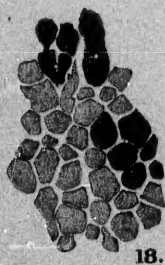
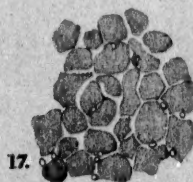
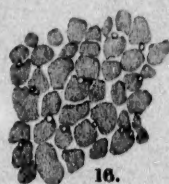
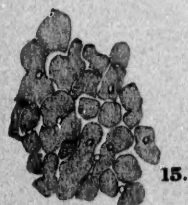
EXPLANATION OF PLATE XX.

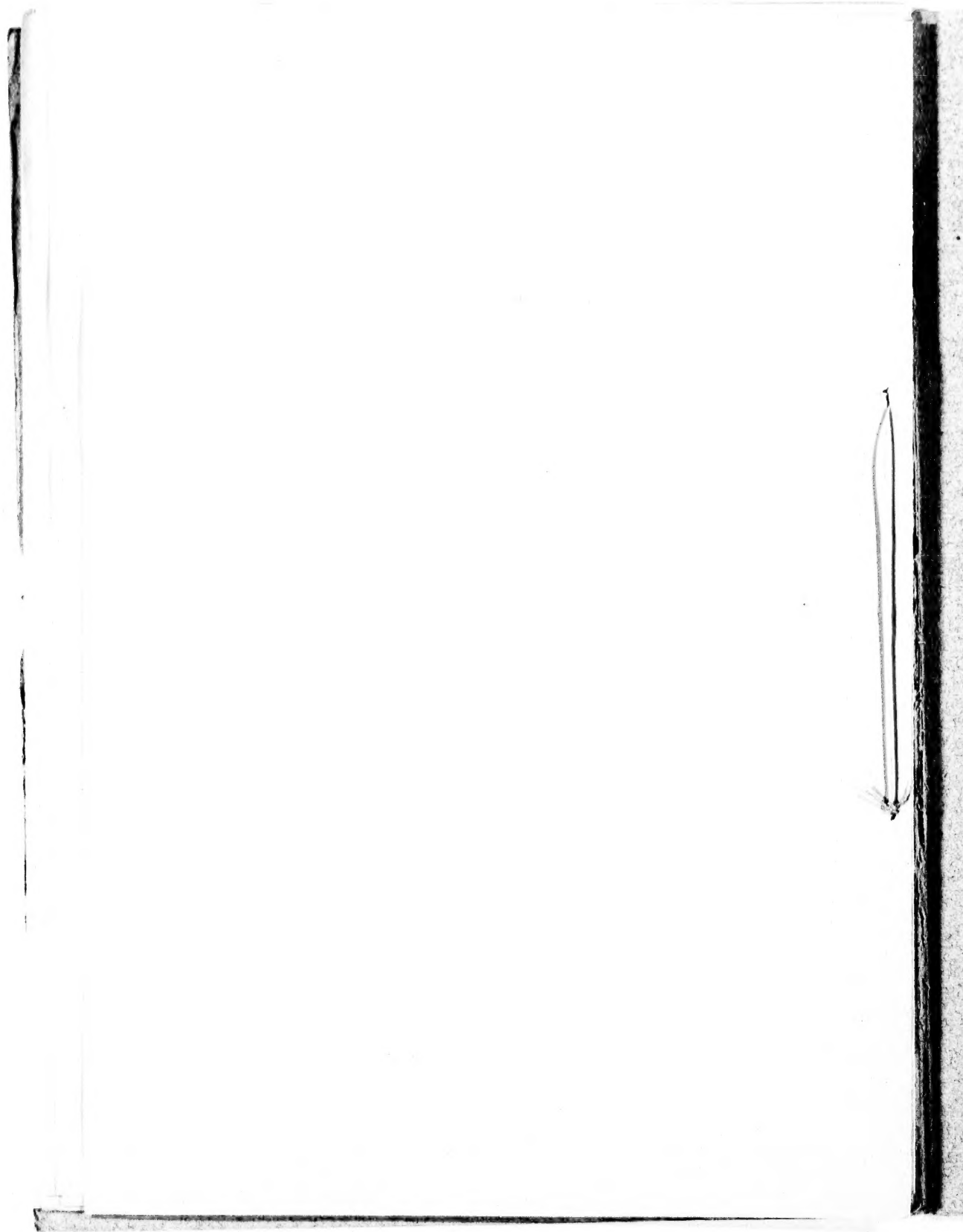
All figures refer to Californian specimens of *Chordodes occidentalis* MONTG.

Figs. 15-20. Surface views of the cuticle of different individuals, fig. 20 from a female, the others from males (obj. C, oc. 4).

Figs. 21, 22. Transverse sections of the cuticle of a male and a female (homog. immers. 1/12, oc. 2).

Fig. 23. Female, ventral view of the posterior end (obj. A, oc. 2).





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